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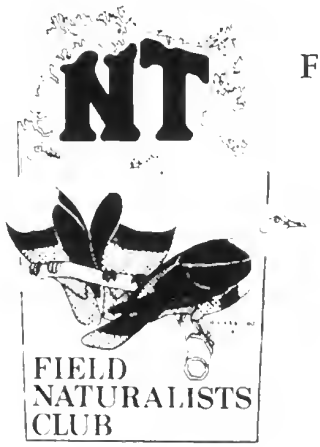

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COVER : Nest of *Crematogaster* sp. in a branch of a Grey Mangrove *Avicennia marina*. Coccid bugs, *Alecanopsis mirus*, are covering much of the walls in the cavity. (M. Nielsen)

Two Specialised Ant species, *Crematogaster* (*australis* Mayr group) sp. and *Polyrhachis sokolova* Forel in Darwin Harbour Mangroves

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Abstract

Some ant species in northern Australia occur exclusively in mangrove communities. One is a species of *Crematogaster*, which nests in the hollowed branches of the Grey Mangrove *Avicennia marina*. The cavities are mostly made by weevil larvae, and the ants tend the coccid bug *Alecanopsis mirus* inside their nests. *Polyrhachis sokolova* is another mangrove specialist, and nests within intertidal mud. Their nests are inundated by up to 61% of high tides, and can be covered with more than 2 m of seawater. The entrances of the nests collapse when flooded and form a plug, which prevents water from penetrating the nest. A cast of the galleries showed that the nest extends up to 50 cm below the mud surface. Drowning experiments showed that the ants can survive immersion in seawater for up to 3.5 hours, but the colony needs to trap air in the nest to survive frequent flooding.

Introduction

Ants have an ability to inhabit most terrestrial ecosystems in the world, and in many environments they are the most important ecological group among animals (Hölldobler & Wilson 1990). Ants are nearly always associated with dry environments, but there are a few exceptions (Nielsen 1986; Yensen *et al.* 1980). One of these exceptions is mangrove communities, which are normally considered as marine ecosystems.

The tropical mangroves in northern Australia are highly productive, and very important breeding and foraging areas for many birds and marine organisms (Hanley 1992). Mangroves are also the breeding ground for several blood-sucking insects (mosquitos and midges), and they have therefore been the subject of many studies on the impact of these insects on humans (Hutchings & Saenger 1987). However little has been published about other mangrove-dwelling insects, and most information about the ant fauna derives from broader investigations and surveys (Ellway 1974; De Baar & Hockey 1987, 1993; De Baar 1994).

The mangroves of Darwin Harbour support at least 16 ant species, most of which are also found in other habitats (Clay & Andersen 1996). However a few species seem to be restricted to mangroves. The contrasting biologies

of two of these species, *Crematogaster* (*australis* Mayr group) sp. and *Polyrhachis sokolova* Forel, are outlined here.

Crematogaster sp.

Like many other *Crematogaster* species throughout the world, this small (2 mm) species nests in cavities within branches (Hölldobler & Wilson 1990). They appear to be restricted to mangroves, and, more particularly to the Grey Mangrove *Avicennia marina*. The ants are not capable of excavating the cavities themselves, but are dependent on holes tunnelled by weevils (De Baar & Hockey 1993). Therefore the nest sites and the extension of the cavities are limited by the abundance of the beetles.

The number of nest-sites in each tree varies markedly. In one of the trees I searched in Darwin Harbour, at least three distinct colonies were identified, and each of them consisted of up to ten separate compartments. The volume of the different compartments in the nest ranged from less than one to several hundred millilitres, but the entrances to them were always less than 2 mm in diameter.

In each colony the functional queens with numerous eggs were located in one chamber, and larvae or pupae were found in most of the other chambers. The most conspicuous insects in many of the chambers were the large (up to 9 mm) pink coccids, *Alecanopsis mirus* Green, which often covered the whole surface of the cavity (Cover Plate). The coccids are strongly attached to the surface of the cavities, and only the first instar nymphs are mobile and capable of moving around in the nest. The attached coccids feed on the plant-sap and produce honeydew, which probably is the main source of energy for the ants.

I established artificial nest-sites, both by drilling holes in, and by attaching branches with drilled holes to, stems. Most of these artificial nests were occupied by ants within 10 days, and first instar coccids were found in three of the nine nests. How the coccids had dispersed is unknown, but given that they are incapable of walking, it is likely that they were transported by ants.

Polyrhachis sokolova

This large (7–8 mm long), black, spiny ant is commonly seen running around on the mud-flats and in trees. It is probably the most "marine" ant species recorded due to its nesting site among crabs and mudskippers. The nests are situated in the mud, and they are found from the drier Spurred Mangrove *Ceriops tagal* to the wet Stilt-rooted Mangrove *Rhizophora stylosa* zones, with nest elevations ranging from 7.22 to 5.99 m above lowest astronomical tide (LAT).

The official data for the tides in Darwin Harbour show that the nests at the highest elevation are inundated on 13 % of the high tides and at durations of up to 1.25 h, whereas the lowest situated nests are inundated on 61 % of the high tides and inundated up to 3.75 h, with up to more than 2 m of seawater above the nest.

How can they survive in these wet conditions? There are two possibilities: either the ants can tolerate immersion in seawater for long periods, or they trap air in the nests, so they can live a terrestrial life in the mud under the seawater. My drowning experiments have shown that the ants are reasonably tolerant to immersion, but after 3.5 h in 30° C seawater the mortality reached 50%. Therefore the colony cannot survive prolonged tidal floodings without having air trapped in the nest.

Excavations of a number of nests showed that they can extend more than 100 x 50 cm. Normally there are two nest-entrances, both elevated above the mud surface and close to the trunk of a tree. The galleries (Plate 1) are most abundant in the upper 20 cm of the mud, but can reach 45 cm depth. The numerous small chambers are situated around the very developed root systems which prevent the air filled chambers from collapsing during the high pressure at maximum tides. Most of the entrances were surrounded by a crater of particulate soil, which the ants have excavated from the nest.

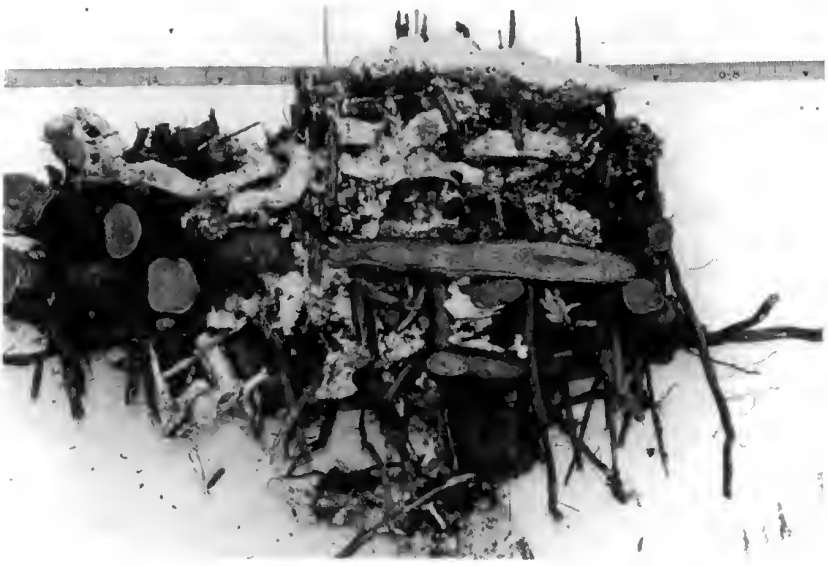

PLATE 1 A polyurethane-foam cast of the gallery system of the mud nesting ant, *Polyrhachis sokolova*. The measuring tape indicates the mud-surface. (M. Nielsen)

When the tide reaches the nest-entrance the loose soil particles collapse and form a stopper, preventing the water from entering. When the tide recedes the ants open the entrances as soon as they are above the water level. The chamber walls are made of clay, which is very impermeable to water, and during excavation at high water level, it was found that all chambers contained air even when they were situated below the water level. During flooding, air can be squeezed out of the nest by treading on the submerged nest.

The ants forage in the trees and on the soil-surface, for a broad range of arthropods. The swollen gaster of some of the returning workers indicate that they also collect liquid food, and they have been observed feeding on bird excrement. At incoming tides the foraging workers often show a special swimming behaviour on the water surface in order to reach the nest-entrance before it is flooded. When the tide recedes the ants start foraging before the soil is dry, and use the same running or swimming behaviour to cross wet areas during their foraging on the mud surface.

Final remarks

These two ant species are examples of specialized insects adapted to live in mangroves. The vast expanses of mangroves in northern Australia, coupled with the extremely limited studies of their insect faunas, make it likely that many more interesting and specialized insects are to be discovered. Unfortunately, fieldwork in mangroves can be unpleasant because of the high temperatures and humidity, and the lack of a cooling breeze. The number of stinging insects can be formidable, and there is always the possibility of meeting saltwater crocodiles! Yet these inconveniences are soon forgotten when working in this fascinating habitat.

Acknowledgements

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Notes on Nests of the Chestnut Rail

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Abstract

We located five active, six recent and six derelict nests of the mangal-inhabiting Chestnut Rail on the southern side of Darwin Harbour during December 1994 and January 1995. The stick nests were up to 2.2 m above the ground and supported in various ways by trunks, branches or roots of mangroves. Nests were concentrated in mangal areas subject to less prolonged inundation, particularly stands of the Spurred Mangrove *Ceriops australis*, but usually close to mangal areas subject to more prolonged inundation. Clutch sizes of two and four were confirmed and the eggs are described. There were at least three breeding pairs of Rails in 18 ha, a density that may have been facilitated by the available juxtaposition of nesting and foraging habitat.

Introduction

The Chestnut Rail *Eulabeornis castaneoventris* is a large rail of tropical mangals (mangrove forests) in Australia and the Aru Islands, Indonesia. Remarkably little is known about the species, and few nests have ever been found (White 1917; Johnstone 1990; Marchant & Higgins 1993). Nevertheless, it is regarded as moderately common in the Kimberley mangals (Storr 1980; Johnstone 1990) and along sections of the Northern Territory coast (Storr 1977), an anomaly attributable to its shyness and the inhospitable nature and inaccessibility of much of its habitat (Pringle & Lindsey 1985). In this note we report on five active and twelve inactive nests found in mangals on the southern side of Darwin Harbour.

Methods

During December 1994 and January 1995 we spent 37.5 person-hours searching for and documenting nests of the Chestnut Rail in mangals lining the Blackmore River and its tributary, the Darwin River on the south-eastern side of Darwin Harbour (12°42′ S, 130° 57′ E). We searched for nests by walking, looking for bulky stick structures and investigating the relatively few places that might support such structures. When both present, we walked 20 to 50 m apart, depending on visibility. We variously followed a compass bearing, a river bank or a vegetation ecotone. When nests were found, information was collected about their habitat, site, structure and contents.

Much of our search effort (30.5 person-hours) was concentrated in the mangal on the east bank of a 1.2 km section of the Blackmore River, and we believe we found most of the nests in this area. This mangal varied from 60 to 400 m wide, and was estimated from the 1:10,000 map to cover 18 ha. Using a GPS navigator, the locations of most nests were plotted on a 1:10,000 map showing mangal boundaries.

Results

We found five active nests, six intact but apparently inactive nests, and six nests in various stages of dereliction. No Chestnut Rails (nor other birds) were observed at these nests. Nevertheless, we are confident in ascribing them all to the Chestnut Rail because of consistencies in, and uniqueness of, construction and placement, as well as the eggs (size, shape and colour), the presence of footprints around active nests, and because the Rails were heard calling near four of the active nests.

Nest density, sites and habitat

In the 18 ha mangal block on the Blackmore River, we found 14 nests, of which four were active and six were recent. On 1 January 1995 three active nests were observed, the fourth almost certainly being a replacement nest for one of these as it was found subsequently within 30 m of a previously active nest. Thus, assuming the species breeds in pairs, density was at least one breeding pair to 0.4 km of river bank (one side) or 0.33 birds per ha. These values are almost certainly underestimates.

All nests were in mangroves, either below or rarely in the lower part of the canopy (Table 1). Nests were supported either by large trunks, branches or roots, or most commonly by a collapsed leaning stem amongst sapling mangroves (Plate 2). Three old nests in the latter situation had collapsed. Foliage cover above the nests was estimated to vary from 30 to 100%.

Eight of fourteen nests (57%) for which the habitat was recorded were in stands dominated by the Spurred Mangrove *Ceriops australis*. The other six were at the upper edges of moister sites in pure stands of Stilt-rooted Mangrove *Rhizophora stylosa* (one nest) or mixed species stands that variously included the Rib-fruited Mangrove *Bruguiera exaristata*, the Slender-fruited Mangrove *B. parviflora*, *R. stylosa* and possibly other species. Although *C. australis* occurred in almost pure stands in broad bands up to 400 m from the river bank, all but one nest in *C. australis* stands were within 100 m of the river bank (we did search further afield). Most were within 20 m of moister, low-lying mangal – the *Bruguiera* and *Rhizophora* zones of Lear & Turner (1977).

PLATE 2 Typical nest of Chestnut Rail on leaning sapling of the Spurred Mangrove. The leaning sapling was used both as support for the nest and as a walkway to the nest. (T. Barnes)

TABLE 1 Summary of nest sites.

Parameters	No. of nests
Height above ground (m):	
median 1.85	
range 1.2–2.2	14
Nest plants (live, unless otherwise stated)	
Spurred mangrove *Ceriops australis*	6
Grey Mangrove *Avicennia marina*	3
Stilt-rooted Mangrove *Rhizophora stylosa*	2
unidentified mangrove, none of above	2
dead plants (unidentified mangroves)	3
Nest situation:	
amongst upright stems or foliage, supported by an angled fallen stem	9
on horizontal portion of stilt roots, against main trunk	2
in horizontal spout	1
in vertical spout	1
in hollow	1
in upright fork	1
on dead horizontal branch, against vertical trunk	1

Nest structure

Nests were bulky platforms, 25–50 cm in diameter and 17–50 cm high. Those in hollows and spouts were smaller than nests built in open situations. The egg cavity ranged from 13 to 25 cm in diameter, and from 1 to 5 cm in depth, and was invariably unlined (Plate 3).

Nests were composed predominantly or solely of mangrove sticks, sometimes with paperbark sticks, wood splinters, bark and a few mangrove leaves and seedlings (hypocotyls). Sticks were mostly 5–10 mm in diameter, with a range from 2 mm to about 20 mm; length was typically 15–40 cm. In two nests where a sample was measured (Table 2), stick diameter declined from the base to the cup. Stick length was greatest in the body of the nest, but shorter and similar at the base and cup. Sticks in the nest body were frequently forked and interlocked; those elsewhere rarely (if ever) so.

TABLE 2 Mean measurements of sticks (n = 10) from each of three sections of two nests of the Chestnut Rail.

Parameter	Stick diameter (mm)		Stick length (cm)	
	Nest 1	Nest 2	Nest 1	Nest 2
Base	13	8	19	13
Body	6	6	31	39
Cup	4	4	20	13

Four nests had gangways, stick constructions extending the nest downwards with the apparent function of facilitating access. However, on only one was this feature prominent, being 55 cm long and 36 cm wide. In the latter case, there was no alternative access pathway. A feature of active nests was the presence of muddy footprints on roots or leaning branches leading up to the nest. Only two nests, at 2.0 and 2.2 metres above the mud respectively, lacked an obvious pathway and may have required access by flight.

Clutch size and egg characteristics

Of five active nests, three contained two eggs, another had three eggs and the last, four eggs. Three of the nests were revisited, and two still contained eggs after intervals of eight and ten days. The third nest was empty, though it was unclear whether the eggs had been taken by a predator or had hatched successfully.

Eggs were moderately to heavily mud-smeared. The basal colour was matt to slightly lustrous cream, with small underlying lavender blotches and brown, tan and rich chestnut surface specks and blotches. In one clutch

the three eggs measured 53–54 x 35–35.5 mm, while in another clutch, one egg measured 46 x 35 mm.

Discussion

Our estimate of the density of breeding pairs is considerably greater than found in Western Australia, where Johnstone (1990) noted ten birds in 3 km and 8 birds in 100 ha (0.08 birds per ha) at two sites. It is consistent with Noske's (in Marchant & Higgins 1993) suggestion that territories may be of 4–5 ha, and W. McLennan's note (in White 1917) that birds "appear to be very local in their habits, and would always remain within a radius of 150 yards (c. 6 ha) of where they were first heard calling". Thus, suitable mangals can and do contain quite high densities of this species.

The scarcity of breeding records of the Chestnut Rail may be attributable not only to the inhospitable nature of mangals in general (Pringle & Lindsey 1985), but also to the concentration of nests deep within mangals (this note) and to the timing of breeding during the "build-up" and wet seasons (Pringle & Lindsey 1985; Storr 1977; Marchant & Higgins 1993) when observer activity may be low and the mangals particularly uninviting. We had little difficulty finding nests, an experience apparently matched only by W McLennan, who found many nests along the King River in Arnhem Land (White 1917).

PLATE 3 Nest of Chestnut Rail, with eggs. Note the shallow, unlined and in this case ill-defined bowl. (D. Franklin)

But what is a suitable mangal? There is a consensus that Chestnut Rails prefer broad bands of dense mangal, especially along the seaward margins or where interlaced with small channels (White 1917; Ragless 1977; Johnstone 1990; Noske 1996), a view consistent with our observations. This could be interpreted as a preference for moister soils inundated regularly and at length by tides, which is where their major food items, small crabs and crustaceans (Johnstone 1990; Marchant & Higgins 1993), are most abundant. However, low-lying mangals may be less suitable for nesting, for with high tides up to 8 m asl and a bulky nest requiring considerable support, suitable inundation-free sites may be lacking. We noted nests on higher ground but close to low-lying areas. The juxtaposition of moist foraging areas and secure nesting sites may be critical for the species, and suggests a readily testable hypothesis for variation in the density of nests and perhaps also of populations of the species.

Acknowledgements

Sean Pywell located and showed TAB an active Chestnut Rail nest, inspiring the search for more nests. Richard Noske assisted with the identification of mangroves. The Conservation Commission of the Northern Territory (Wildlife Research Section) lent us one of their GPS units. Alan Andersen, Jenny Carter, Ron Johnstone and Richard Noske commented helpfully on a draft of this note.

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Records of Two Introduced Rodents, *Mus musculus* and *Rattus rattus*, from Bushland in Elsey National Park

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Across much of southern and central Australia, feral Rabbits *Oryctolagus cuniculatus*, House Mice *Mus musculus* and Black Rats *Rattus rattus* are often the most numerous small mammals, even in relatively undisturbed habitats. In northern Australia generally, and the Top End in particular, there are few records of feral small mammals occurring outside the restricted areas of urban development (Fig. 1). For example, no feral small mammals were recorded from a series of wildlife surveys (> 200,000 trap-nights) during 1992-1995 in native vegetation across the Top End (Woinarski in press). Yet a recent comprehensive fauna survey of Elsey National Park (14° 55′ S, 133° 10′ E; mean annual rainfall = 750 mm), 100 km south of Katherine (Fig. 1), revealed both the House Mouse and Black Rat in apparently unmodified native vegetation. This paper provides details of these records.

Elsey National Park was surveyed during December 1996, using Elliott and cage traps within each of 31 x 1 ha quadrats, located in a range of representative vegetation types (total of 2,325 trap-nights). Three Black Rats were trapped from three quadrats, and a fourth was trapped incidentally in a storage shed at the main campground (12 Mile). Vegetation at two of the quadrats consisted of tall *Melaleuca* forest adjacent to permanent spring-fed water courses, while the third was open woodland and situated more than 2 km from permanent water (Appendix 1). Four House Mice were captured at two quadrats, both dominated by *Melaleuca cajuputi* with an understorey dominated by the sedge *Scleria brownii* (Appendix 1). Permanent water was available in the first quadrat, but not the second (although water would be freely available during wet-season months). The distance between the capture sites and the closest human habitation was up to 10 km and 13 km for the Black Rat and House Mouse, respectively.

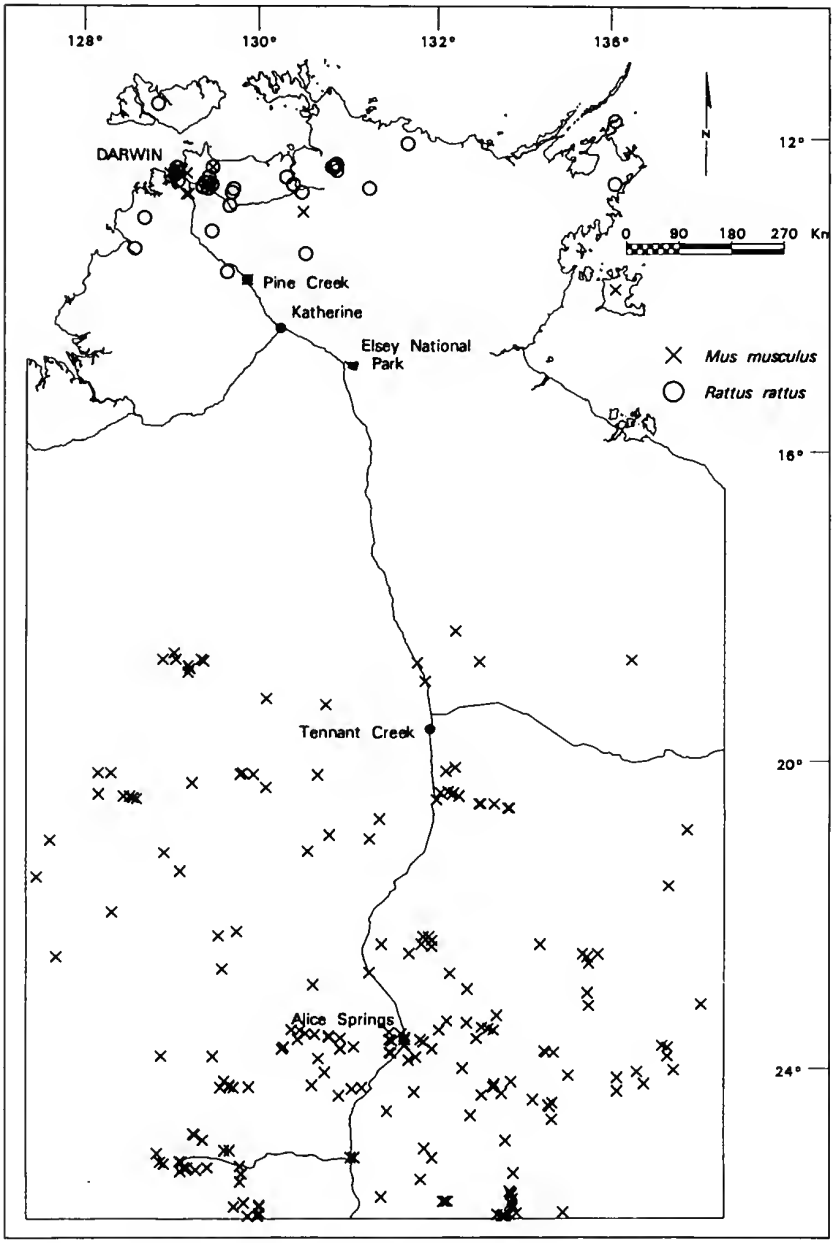

FIGURE 1 Location of historical records of *Rattus rattus* and *Mus musculus* in the Northern Territory, and location of Elsey National Park.

The Black Rat records represent a substantial extension of the previous southernmost record for this species in the Northern Territory (latitude 13° 43' S). The House Mouse has a widespread distribution south of latitude 18° S, but north of this latitude there is a 400 km distribution gap until 14° S (Fig.1). The records above 14° S are relatively few (n = 21), and always associated with towns. Many of the previous records for both the Black Rat and the House Mouse are from towns (e.g. Darwin), with the remainder situated close to human settlements in the north-west of the Top End. However, there is a substantial Black Rat population on the little modified Truant Island off the north-east coast (J. Woinarski, unpubl. data).

Do the Elsey National Park records represent a slow expansion in the distribution of these two introduced mammal species in northern Australia? Disturbance of natural environments generally favours introduced vertebrate species. Possibly the region's long history of grazing and use as a major stock route has disturbed the environment sufficiently for colonisation by these two rodents. At present, a large population of feral donkeys inhabit most areas of the Park, but particularly the riparian forests.

The contrast in the distribution of House Mice between the southern and northern regions of the Northern Territory is puzzling, and may offer some insights. Central Australian populations of the species persist in undisturbed habitats, and even mirror irruptive patterns of native rodents (Newsome & Corbett 1975). Their limited distribution in the wet-dry tropics suggests that high rainfall creates an unsuitable environment for the House Mouse. Elsey National Park is located between the wet-dry tropical and semi-arid zones, and may be sufficiently arid for them to persist away from human settlement. In addition these findings clearly illustrate that the distribution of House Mice is not continental, as suggested by Singleton (1995).

The reverse may be true for the Black Rat to persist away from human settlement in northern Australia. It is restricted to higher rainfall areas in southern and eastern Australia (Watts 1995), and in the wet-dry tropics is restricted to human settlements in areas with rainfall exceeding 1,000 mm per year. At Elsey National Park, Black Rats were mainly confined to riparian habitats, although the capture in open woodland suggests that they are capable of invading what was previously thought to be unsuitable habitat, and of substantial dispersal from towns. Further trapping in the area is desirable to establish the extent of distribution of these species within the Park, and to monitor their occurrence in the transition zone between semi-arid and tropical northern Australia.

Acknowledgements

I would like to thank Parks and Wildlife staff Kathy Wilson, Chris Materne, Damian Milne and John Scott, and volunteers Judy Manning, Marisa Fontes and Jack Hare for assistance with trapping. Damian Milne prepared the map and John Woinarski provided comments on an earlier draft.

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APPENDIX 1 Summary of quadrats where individual Black Rats and House Mice were captured in Elsey National Park, Northern Territory.

Species	Location	Dominant plants*	Habitat and location	Distance (km) from human settlement
R. rattus	14° 56' 20" S 133° 08' 10" E	*M. dealbata* *Li. rigida* *P. aquaticus*	Tall riparian forest at junction of Water House R and Little Roper Ck	1
R. rattus	14° 56' 30" S 133° 08' 45" E	*M. dealbata* *Li. rigida* *F. racemosa*	Tall riparian forest close to Little Roper Ck	2
R. rattus	15° 01' 40" S 133° 12' 01" E	*G. americanus* *E. chlorostachys* *Ly. cunninghamii*	Eucalypt open woodland on Roper Hwy	10
R. rattus	14° 57 '14" S 133° 13 '13" E	Not applicable	Storage shed at 12 Mile camp-ground	0
M. musculus	14° 54' 59"S 133° 05' 59" E	*M. cajuputi* *Lo. grandiflorus* *S. brownii*	Tall riparian forest with sedge understorey downstream of Bitter Springs on Little Roper Ck	1
M. musculus	14° 58' 45"S 133° 11' 58" E	*M. cajuputi* *P. spiralis* *S. brownii*	Low woodland in drainage depression in 'Jungle Paddock'	13

* Letters for genera: *M, Melaleuca; Li, Livistona; P, Pandanus; F, Ficus; G, Gyrocarpus; E, Erythrophleum; Ly, Lysiphylum; Lo, Lophostemon; S, Scleria.*

Opportunistic Observations of Marine Mammals from the Coastal Waters of Fog Bay, Northern Territory

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Abstract

Four species of marine mammals were observed from a small boat during sea-turtle research activities in Fog Bay, west of Darwin. The Indo-Pacific hump-backed dolphin was the most frequently sighted, followed by the dugong, Irrawaddy dolphin and bottlenose dolphin. Details of each sighting, including exact location, season, group size and number of calves are provided.

Introduction

The tropical coastal waters of Australia support four species of marine mammals, comprising the dugong *Dugong dugon* and three species of dolphins (Indo-Pacific hump-backed dolphin *Sousa chinensis*, Irrawaddy dolphin *Orcaella brevirostris*; bottlenose dolphin *Tursiops truncatus*) (Marsh *et al.* 1995). Dugongs are found in tropical and sub-tropical coastal and island waters from eastern Africa to Vanuatu but are listed as vulnerable to extinction (IUCN 1990) as their populations have declined markedly in many parts of their range (Marsh *et al.* 1995). Indo-Pacific hump-backed dolphins are widely distributed throughout coastal habitats of the Indian and western Pacific oceans (Ross *et al.* 1994), Irrawaddy dolphins are found in coastal and riverine areas from India to eastern Australia (Marsh *et al.* 1989), while the bottlenose dolphin has a cosmopolitan distribution throughout tropical and warm temperate waters (IUCN 1995). The abundances of these dolphin species are thought to have declined in many parts of their respective ranges, although evidence is weak and the extent of human induced mortality remains unknown. Threats include direct hunting, incidental capture by fishing activities, shark netting and degradation of the environment. They are all classified as "insufficiently known" (IUCN 1990).

In the Northern Territory, aerial surveys (Bayliss 1986; Bayliss & Freeland 1989; Freeland & Bayliss 1989) and incidental information (Harwood & Hembree 1987) have provided some data on the distribution and abundance of dugongs and dolphins, although these remain limited or non existent for most areas of the coastline. For this reason baseline data are required to

identify areas which are important to dolphins and dugongs so that more systematic monitoring can be conducted in the future. This note reports opportunistic sightings of marine mammals in shallow coastal waters 50 km west of Darwin.

Methods

Opportunistic sightings of marine mammals from the coastal waters between Native Point (12° 43′ S, 130° 20′ E) and Quail Island (12° 30′ S, 130° 26′ E), Fog Bay (Fig. 1) were made during sea turtle research activities between October 1995 and October 1997.

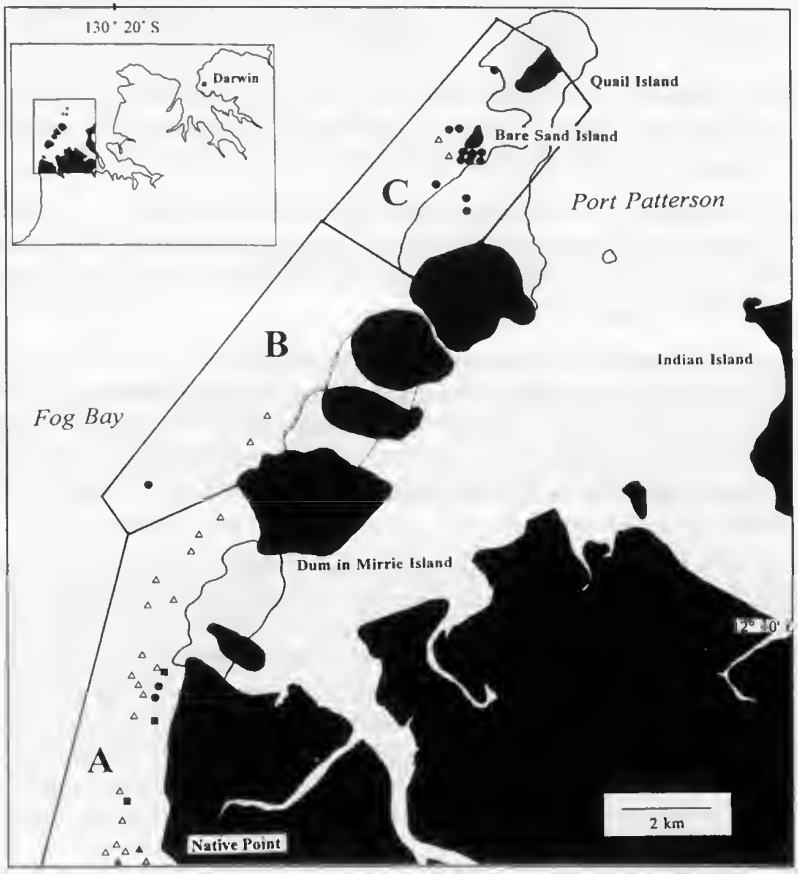

FIGURE 1 Map of marine mammal sightings in Sectors A, B & C in Fog Bay. Solid circles, dugongs; unfilled triangles, Indo-Pacific humpback dolphins; solid triangles, bottlenose dolphins; solid squares, Irrawaddy dolphins.

The area is characterised by shallow, turbid, coastal waters which experience a large tidal range (8 m) (Department of Defence 1997). The western mainland coast is rocky with some sections of sand, while the mainland coast to the east (Port Patterson) and the islands extending to the north are dominated by mangroves.

Observations were made by one person from a 3 m dinghy operating at variable speeds within 3 km of the shoreline in Sectors A, B & C and from a shore based station in Sector C (Fig. 1). Sectors were used to analyse the sightings because observation time varied between sector and season; wet (Nov.-Apr.) and dry (May-Oct.) (Bureau of Meteorology 1989). Details of how and when observations in each sector were made are listed below.

Sector A -Native Point (Dundee Beach) to Dum in Mirrie Island
Observations were made from a boat (during transit within the sector). This sector had the greatest number of observation hours.

Sector B – Dum in Mirrie island to North End of Grose Island
Observations were made from a boat (during transit within the sector). This area had the fewest observation hours. Most observations hours occurred during the dry season.

Sector C – Around Bare Sand Island and Quail Island
Observations were made from a boat (during transit within the sector) and from a shore based station on Bare Sand Island. Observations were conducted mainly between April and August, with intensive observation periods in June 1996 and June/July 1997 and few during the wet season.

Data recorded included species (identification using Leatherwood *et al.* 1983), number of individuals in a group, number of calves, location, and time (Corkeron 1997). Locations were determined using a Global Positioning System (GPS) or bearings to prominent coastal landmarks. Transect width was not used to create population estimates or densities because of the limited and opportunistic nature of the data and the small area surveyed. Sighting rate (number of groups sighted / observation hours) was calculated for each sector and season to determine sighting frequency. Sighting rate was used to compare between sectors and season.

Species occurrence relating to tidal state was investigated using circular statistics (mean angle, mode, chi-squared goodness of fit test with Rayleigh's test) (Zarr 1984). The tide state was scored as the number of hours after the previous high tide (e.g. 3, mid falling; 6, low; 9, mid rising;

12, high). Spring and neap tides were not differentiated because of limited data.

Results

All four species of marine mammals were observed in Fog Bay during the 24 month period (Table 1; Appendix 1). Indo-Pacific hump-backed dolphins were the most common species sighted (54%), followed by dugongs (34%), Irrawaddy dolphins (7%) and bottlenose dolphins (5%).

TABLE 1 Summary of sightings of marine mammals at Fog Bay, 1995–1997.

Species	Total no. sightings (%)	Total no. individuals* (%)	Percentage calves	Group size* (mean, sd, range)
D. dugon	15 (36)	18 (12)	27	1.2, 0.56, 1-3
S. chinensis	22 (52)	80 (55)	8	3.7, 2.87, 1-10
O. brevirostris	3 (7)	39 (27)	0	13.0, 8.19, 4-20
T. truncatus	2 (5)	8 (6)	25	4.0, 2.83, 2-6
Total	42 (100)	145 (100)	25	4.0, 2.83, 2-6

* including calves.

Dugongs were commonly seen alone, and the mean ($\pm$ *sd*) size of 15 groups was 1.2 ($\pm$ 0.56). Sightings were uniformly distributed around the tidal cycle ($\chi^2 = 8.26$, $v = 11$, n = 15, $0.75 < P < 0.90$) with no mean tide state detectable (Rayleigh's $z = 0.648$, n = 15, $P > 0.50$). Dugong calves were observed between April and July and on three occasions subadult sized dugongs were observed alone. Dugongs were sighted more frequently in the dry season (Table 2), although seasonal observations were dominated by many sightings during June/July 1997 in Sector C. On two occasions (in May 1996 and June 1997) a dugong of juvenile size was observed lying motionless on the intertidal reef flat in shallow water (depth 1 m) in Sector C. Both sightings were in the same vicinity and were about 400 m from deeper water. Seagrass in this area occurs mostly subtidally and was not observed within 1 km of this location. The second of these dugongs was captured to examine obvious damage to the caudal peduncle which included deep lacerations that could have been inflicted by a fishing net or line. The damage was not fresh although it continued to bleed and secrete clear fluid. The dugong was weak but swam off after being released two minutes after capture. Three remoras *Echeneis naucrates* were attached to its underside.

Indo-Pacific hump-backed dolphins were observed more frequently during the wet season (Table 2), and if Sector B is disregarded because of low observation effort, more frequently in Sector A than Sector C. The 22 sightings were not uniformly distributed around the tidal cycle ($\chi^2 = 30.1$, $v = 11$, $0.001 < P < 0.005$), but more frequent during the low rising tide between tide state 6 and 10 (mode = 7, mean tide state = 9, Rayleigh's $z = 4.82$, $0.005 < P < 0.01$). The maximum size of these groups was ten, with a mean ($\pm$ *sd*) group size of 3.7 ($\pm$ 2.87). Calves were seen in both seasons. A large proportion of the individuals had white markings on their dorsal fin or body.

Irrawaddy dolphins were observed on three occasions only, all during the dry season of 1996. Group size ranged from four to 20, with a mean of 13.0. Bottlenose dolphins were observed on two occasions in Sector A: one in the wet season and one in the dry season (Table 2, Fig 1). Calves of these two species were not observed.

TABLE 2 Number of groups sighted, and group sighting rate (in brackets, h^{-1}) for each sector and season.

Sector/season		Species				
	Obs.*	*D. dugon*	*S. chinensis*	*O. brevirostris*	*T. truncatus*	All
Wet season						
A	62.4	1 (0.02)	14 (0.22)	3 (0.05)	2 (0.03)	18 (0.29)
B	1.8	1 (0.55)				1 (0.55)
C	9.0		1 (0.11)			1 (0.11)
Dry season						
A	51.3	1 (0.02)	5 (0.10)			6 (0.12)
B	9.2		2 (0.29)			2 (0.22)
C	81.8	12 (0.15)	1 (0.01)			12 (0.15)
Pooled data						
Wet	73.3	2 (0.03)	15 (0.21)	3 (0.04)	2 (0.03)	22 (0.30)
Dry	142.3	13 (0.09)	7 (0.05)			22 (0.10)
A	113.8	2 (0.02)	12 (0.17)			14 (0.12)
B	11.0	1 (0.09)	2 (0.18)			1 (0.09)
C	90.8	12 (0.14)	2 (0.01)			12 (0.13)
Total	216	15 (0.07)	23 (0.11)	3 (0.01)	2 (0.09)	43 (0.20)

*Observation time in hours.

Discussion

The most frequently observed species recorded from the study area was the Indo-Pacific hump-backed dolphin. This contrasts with other studies which show that dugongs are the most abundant species of marine mammal in inshore waters of northern Australia (Marsh *et al.* 1995). This difference may be because the observations in the Fog Bay study were from a boat, opportunistic, conducted over a small study area, small in sample size and lacked indexes for sightability (Marsh & Sinclair 1989a,b). Even though regular boat surveys of small areas (such as those conducted in Fog Bay) may not be comparable to aerial surveys, they can provide detailed information on small scale habitat use and seasonality and help to identify critical habitat. They also allow closer identification of dolphin species which can be difficult from the air.

Dugongs may have been sighted more frequently during the dry season because the study area is exposed to strong westerly winds and seas during the wet season which may cause dugongs to move to more sheltered waters (e.g. Port Patterson) during this period. The frequency and regularity with which dugongs were sighted in the channel adjacent to Bare Sand Island (Sector C) indicates that this area is important and regularly used, possibly because it offers an area of localised shelter or supports subtidal seagrass. Similarly, the area around an intertidal rock pool on the mainland coast in Sector A appears to be important to dugongs. Group sizes of dugongs in Fog Bay were similar to those reported in other studies (Bayliss 1986), although large groups consisting of up to 40 individuals have been observed several times in recent years approximately 15 km west of Dum in Mirrie Island (M., M. & D. Baumber, pers. comm.). The observations of the two dugongs on the reef flat in Sector C were interesting because seagrass does not occur in this habitat. Dugongs may use these shallow areas to avoid large sharks when they are sick or injured. This was the case for the second dugong observed in this location which was weak and had a severe laceration to the caudal peduncle, probably caused by a monofilament line or net.

The distribution and abundance of Indo-Pacific dolphins is not well known in northern Australia (FAO 1993; Ross *et al.* 1994). Group sizes (< 10) in Fog Bay conform to those reported elsewhere (FAO 1993). White markings observed on individuals were similar to those reported in Queensland (Ross *et al.* 1994). Although seasonal movements have not been identified for any population (Ross *et al.* 1994), groups in Fog Bay were observed more frequently in the wet season. Observations of Indo-Pacific hump-backed dolphins in Fog Bay feeding on the low rising tide are supported by similar observations of behaviour reported by Ross *et al.* (1994).

PLATE 4 An adult dugong surfacing for air at Ashmore Reef. (S.D. Whiting)

Two of the three groups of Irrawaddy dolphins sighted were large, the mean group size being 13.0. This contrasts with the mean group size of 1.63 reported by an aerial survey of this region (Freeland & Bayliss 1989). FAO (1993) state that group sizes fewer than six are usual, but groups of up to 15 individuals have been reported. These sightings are important as little is known about this species in Australia. Bottlenose dolphins were relatively uncommon in the inshore waters of Fog Bay, in contrast to the situation in the cooler coastal waters of central Western Australia (Preen *et al.* 1997).

These opportunistic sightings add to existing records of marine mammals along the NT coast (Marsh 1988; FAO 1993). Opportunistic boat based surveys, although not as rigorous as specifically designed boat-based (Gill 1997), land-based (Aragones 1994; Rugh *et al.* 1990) or aerial (Marsh & Sinclair 1989a, b) surveys, offer the benefit of detailed information without the high costs which are involved in operating surveys independently of other projects. If used in conjunction with other studies, this type of survey can be cost-effective means of gathering baseline data on presence and relative abundance as well as details on habitat use, behaviour and seasonality.

Acknowledgements

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Appendix 1 List of observations of marine mammals from Fog Bay, Northern Territory.

Date	Time	SP	Group size	Calves	Sect.	Lat.	Long.	Tide Ht (m)
07/10/95	1115	S	3		A	12 39.00	130 20.30	6
29/10/95	1120	S	10	2	A	12 40.00	130 20.30	12
08/11/95	1120	S	8	1	A	12 43.20	130 20.30	7
08/11/95	1145	S	3	1	A	12 42.50	130 20.30	7
20/11/95	1115	S	2		A	12 40.50	130 20.30	7
24/11/95	1030	S	5	1	C	12 32.30	130 24.40	4
07/12/95	1315	S	5		A	12 43.20	130 21.00	8
07/12/95	1730	S	2		A	12 41.00	130 20.30	11
02/02/96	1530	S	1	1	A	12 39.50	130 22.70	10
03/02/96	1500	S	1		A	12 40.20	130 20.50	9
04/02/96	1500	S	2		A	12 42.00	130 20.30	8
15/03/96	1230	T	6	2	A	12 43.20	130 20.30	10
14/03/96	1015	S	2		A	12 41.80	130 20.55	10
15/04/96	1430	D	1		A	12 40.40	130 20.85	9
26/05/96	0950	D	1	1	C	12 25.10	130 33.10	2
28/05/96	0930	O	15		A	12 42.80	130 20.40	7
02/06/96	1530	D	3	1	C	12 33.24	130 24.58	6
06/07/96	0800	S	10		B	12 37.50	130 21.80	2
29/06/96	0900	O	20		A	12 41.50	130 20.70	5
08/08/96	1300	O	4		A	12 40.45	130 20.80	2
11/08/96	1215	D	1		A	12 40.95	130 20.70	8
24/09/96	1000	S	6		A	12 43.30	130 20.65	6
09/11/96	1200	S	1		A	12 47.00	130 20.50	7
09/11/96	1330	S	1		A	12 39.50	130 21.00	9
27/11/96	1700	S	1		A	12 37.50	130 21.30	10
28/11/96	0830	S	3		A	12 38.30	130 21.20	7
08/04/97	1300	D	1	1	B	12 37.75	130 20.12	7
28/04/97	1500	S	7		A	12 39.30	130 21.00	6
06/04/97	1100	T	2		A	12 43.00	130 20.00	6
25/06/97	1700	D	1		C	12 32.00	130 24.60	8
26/06/97	1200	D	1		C	12 32.50	130 25.00	3

continued

Appendix 1 (continued) List of observations of marine mammals from Fog Bay, Northern Territory.

Date	Time	SP	Group size	Calves	Sect.	Lat.	Long.	Tide Ht (m)
27/06/97	1430	D	2		C	12 32.00	130 24.60	9
28/06/97	1630	D	1		C	12 31.40	130 25.20	10
29/06/97	1100	D	1		C	12 33.46	130 24.66	11
29/06/97	1300	D	1		C	12 32.50	130 25.00	1
07/07/97	1700	S	2		B	12 37.50	130 21.80	10
07/08/97	1100	S	3		A	12 41.20	130 20.30	3
15/07/97	1330	D	1	1	C	12 32.50	130 25.00	1
15/07/97	1630	S	2		C	12 32.50	130 24.70	4
16/07/97	1400	D	1	1	C	12 32.50	130 25.00	12
09/07/97	1200	D	1		C	12 32.50	130 25.00	9
11/07/97	1300	D	1		C	12 32.50	130 25.00	4

DATE = dd/mm/yy, SEAS.= SEASON (wet season, dry season), Time = 24 hour, SP = Species (D=Dugong, S=Indo-Pacfic hump-backed dolphin, O = Irrawaddy dolphin, T=Bottlenose dolphin), GROUP SIZE = No. of individuals in group, CALVES = No. of calves in group, SECT = Section of Study Area (A, B, C), LAT. = Latitude, LONG. = Longitude, TIDE HT = Tide Height (number of hours after high tide,e.g. 3 = mid falling, 6 = low, 9 = mid rising, 12 = high), TIDE STATE = spring (S) or Neap (N) tides.

Observations of Birds on Islands in Northern Fog Bay, Northern Territory

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Abstract

A total of 74 species was recorded for small islands in northern Fog Bay, mostly during the dry seasons of 1995, 1996 and 1997. Large flocks of up to 2000 Lesser Frigatebirds flew over the islands each evening. Four nests of the Beach Stone-curlew were found on Quail Island, representing the first fully documented breeding records for the Northern Territory. The Sooty Oystercatcher, generally scarce in the Territory, nested on three islands during the study period, though this species is generally considered a spring-summer breeder. Two nesting colonies of Crested Terns, each with 160–200 eggs, were found in May 1996, but both were apparently destroyed by tidal inundation.

Introduction

The distribution, abundance and seasonality of birds in many parts of the Northern Territory remain poorly documented due to the paucity of observers. Major exceptions are the Darwin region (Crawford 1972; Thompson & Goodfellow 1987), Cobourg Peninsula (Frith & Hitchcock 1974) and north-eastern Arnhem Land (reviewed in Gambold *et al.* 1995). Avifaunal surveys have recently been conducted on many of the large islands off the coast of the Northern Territory (Fensham & Woinarski 1992; Fisher *et al.* 1996; Noske *et al.* in press) but little is known about the avifauna of small islands close to Darwin. Broadscale surveys of feeding areas and breeding colonies of shore-, water- and sea-birds in coastal areas and islands of the Northern Territory are currently being conducted by the Parks and Wildlife Commission of the Northern Territory (R. Chatto, unpubl. data). This paper documents opportunistic observations of some species of birds from several islands in northern Fog Bay, and includes a bird list for the area.

Study sites and methods

Bare Sand Island (12° 31' S, 130° 26' E) is the seventh of eight ironstone islands in northern Fog Bay which extend north of the mainland, 50 km west of Darwin (see map in Whiting 1997). It is approximately 20 ha in

area, and composed of sand dunes with low shrubs and four trees (three Coastal She-oaks *Casuarina equisetifolia* and one Black Wattle *Acacia auriculiformis*). Quail island (12° 32' S, 130° 25' E) is the eighth island in the chain and has a larger area (200 ha) and higher relief than Bare Sand Island. It supports several different habitats, including large expanses of grassland (Plate 5), small pockets of monsoon vine thicket and some fringing mangroves.

Djedjelbity Islet is located between, and slightly to the east of, Bare Sand and Quail Islands. It is approximately the size of Bare Sand Island and is comprised of rock to the east, mangroves to the west, and sand and low vegetation in the middle. These islands are about 12 km from the mainland. Middle Reef (12° 28' S, 130° 31' E) is located 10 km north-east of Quail Island and 7 km west of Cox Peninsula, and comprises an intertidal reef flat and a semi-permanent sand bank, which is totally submerged at spring high tides, but approximately 0.1 ha in area at a tide height of 7 m.

SDW visited Bare Sand and Quail Islands for 29 days during June and July 1996, and for 42 days from May to August 1997, accompanied by DD in May 1996, and RAN and MLG in July 1996. Middle Reef was visited in June and August 1996 (SDW). On several occasions between 1990 and 1996 RC visited Bare Sand and Quail Islands, as well as Windir Island which is located between Grose and Beer Eetar Islands, 5 km south of Bare Sand Is, and 5 km from the mainland.

Results

A total of 74 bird species was recorded from the islands during this period. This included 52 species from Bare Sand Island, 46 from Quail Island, and 26 from Djedjelbity Islet. Although Quail Island is larger and has a greater diversity of habitats than Bare Sand Island fewer species were recorded from the former, probably largely due to the greater time spent on the latter. Appendix 1 lists the species and their scientific names. In the following section we provide details of observations of species that are scarce in the Darwin region, or for which nesting or other behavioural data are scant for the Northern Territory.

Lesser Frigatebird

Each evening from approximately 16:30 until dark at 19:00, Lesser Frigatebirds arrived in the vicinity of Bare Sand or Quail Island in a continuous stream from the south and west. They soared on thermals, usually over 100 m in altitude. In 1996 they either formed one group over one of the islands or separate groups over Quail and Bare Sand Islands. In 1997 they sometimes formed a group over the smaller Djedjelbity Islet.

Flocks of between 500 and 2000 were recorded, but most were of about 1000 birds. Although it is possible that other Frigatebird species were occasionally present, the vast majority was certainly of this species.

The Lesser Frigatebird is an uncommon visitor to Darwin, where flocks of up to 35 birds have been reported, mostly during, or following, stormy weather in the wet season (McKean & Gray 1973; McKean *et al.* 1975). Similar behaviour has been reported during cyclones in Queensland (Lindsey 1987). The flocks in Fog Bay were larger than previously reported for non-nesting aggregations in northern Australia. Groups of less than 30 *Fregata* spp have been recorded in the northern Great Barrier Reef (Warham 1962). In Fog Bay the Frigatebirds presumably roosted in the mangroves as elsewhere this species is known to soar over roost sites for hours in the late afternoon before landing (del Hoyo *et al.* 1992). The species does not breed in Northern Territory waters (R. Chatto, unpubl. data), and the nearest breeding colony to Fog Bay is Ashmore Reef, 800 km to the west (Marchant & Higgins 1990).

PLATE 5 Grassland habitat on Quail Island. (S. D. Whiting)

Great-billed Heron

A pair of Great-billed Herons was regularly seen on Quail Island in both 1996 and 1997. The birds were often seen roosting in the same tree during 1996 and would invariably fly to nearby Djedjelbity Islet when disturbed. As three birds were seen together on 5 August 1997 (RC) it is possible that the pair had bred, and that the third bird was their offspring.

The status of the Great-billed Heron in the Northern Territory is poorly understood. It is thought to have a continuous range across the Top End but there are few published records between Darwin and the Western Australia – Northern Territory border (Blakers *et al.* 1984). Storr (1977) claimed that the species breeds in December and January in the Northern Territory, yet published records show that the breeding season in monsoonal Australia incorporates the dry season. In large estuaries of the Kimberley region, Western Australia, where the species is moderately common, a nest with one large young was found on 8 May 1986, and another two empty, but fresh, nests in May 1966 and July 1973 (Johnstone 1990). McLennan found a nest with one "fully-fledged young" on the west coast of Cape York on 7 July 1915 (White 1917: 212). With only one breeding record for the species during the five years of the 1977-82 Field Atlas (Blakers *et al.* 1984), it would be worthwhile determining if breeding occurs in Fog Bay.

Beach Stone-curlew

Beach Stone-curlews were observed on the beaches of Quail Island, Bare Sand Island and Djedjelbity Islet. Breeding was noted only on Quail Island where groups of up to eight individuals were occasionally seen, though pairs were more usual. During 1996 and 1997 four nests were found in open grassy areas behind the first dune on the western and northern sides of the island, by following the tracks of Stone-curlews along well-used paths leading from the beach to the nest. Nests usually comprised a collection of a few dried roots and sticks (Plate 6).

In 1996, on the western side of the island, a nest contained an egg on 24 June and 12 July, but was empty by 10 August, when another nest with one egg was found nearby. A third nest with one egg was observed on the northern end of the island on 12 July 1996. On 24 June 1997 a nest with one egg was observed only 100 m from the first nest of the previous year. Although the nest construction was similar to the others, this one was built under the shade of a large spreading tree. Five Stone-curlews were observed in the branches directly above the nest. No hatchlings or fledgings were observed on the island in either year.

The species was regularly heard during the night, and observed during the early morning, on Bare Sand Island. Up to three birds were also regularly seen on the northern beaches of Fog Bay. On 24 September 1996 a Beach Stone-curlew chased a goanna *Varanus panoptes* from behind the first sand dune and down onto the intertidal area until the goanna retreated under beach rock. Such aggressive behaviour may have been in defence of a nest.

The Beach Stone-curlew is considered vulnerable in Australia with a national population size estimated at approximately 1000 individuals (Garnett 1993), although recent surveys of previously unexplored parts of the Northern Territory coast suggest that this is an underestimate (Fisher *et al.* 1996; R. Chatto, unpubl. data). Counts made on Quail Is, combined with sightings from other islands and from the beaches along the mainland, suggest that at least 25 individuals occur in northern Fog Bay. Group sizes on Quail Is were large compared to those reported along the northern Great Barrier Reef (Warham 1962) and elsewhere in the Northern Territory (R. Chatto, unpubl. data). As there is some evidence that this (and other bird) species feeds on hatchlings of the Flatback Turtle *Natator depressus*, it is possible that these larger groups represent feeding aggregations.

PLATE 6 Nest and egg of Beach Stone-curlew, Quail Island. (R. A. Noske)

The four breeding records of Beach Stone-curlews on Quail Island over two consecutive years are significant as there were only 15 documented breeding records for Australia up until 1992 (Marchant & Higgins 1993). Breeding at Fog Bay accords with the July-August breeding season of the species reported for the Kimberley coast of Western Australia (Storr 1980), though it started somewhat earlier (June) in both years. However, it is inconsistent with information in Marchant & Higgins (1993), who report Nest Record Scheme records of eggs in mid-September and early October in the Northern Territory.

Sooty Oystercatcher

Up to eight Sooty Oystercatchers of the distinctive "spectacled" race *ophthalmicus* were regularly observed on Bare Sand and Quail Islands, and on irregular visits to Djedjelbity Islet. On 17 August 1995 one nest was found on each of the two main islands, one with a single egg and the other with two eggs (RC). On 23 June 1996 a nest with one egg was observed behind the first dune on the southern beach of Quail Island (SDW). All nests consisted of a small depression in sand (Plate 7).

Three nests were seen in 1997. On the southern end of Quail Island a nest containing one egg was found on 23 June (SDW), while a second nest, possibly belonging to the same pair, was found on 5 August, and contained two eggs (RC). A third nest, containing two eggs, was found on Djedjelbity Islet on 17 July (SDW). On the northern end of Bare Sand Island an adult bird displayed defensively towards humans every day during the second week of July. Nesting was suspected, but a search for the nest was not conducted. No hatchlings or fledgings were observed on any of the islands.

Sooty Oystercatchers are generally scarce along the Northern Territory coastline, and moreso in the western half, including Darwin (Crawford 1972; Thompson 1977; Shurcliff 1993). The breeding months of June-August at Fog Bay are at variance with the only other published breeding record in the Northern Territory, which refers to a nest with two eggs on Maine Island (near Cape Stewart) on 17 September 1915 (White 1917). A nest with one egg was found on one of the Sir Edward Pellew Islands on 29 September 1994 (R. Chatto, unpubl. data). Marchant & Higgins (1993: 745) claimed that breeding in Australia occurs from "October to January, rarely February". Given that the clutch is usually two eggs and "occasionally one" (Marchant & Higgins 1993: 745) it is interesting that three of the six clutches at Fog Bay were of a single egg, though it is possible that one or more were incomplete.

Pied Oystercatcher

Pied Oystercatchers formed larger aggregations than Sooty Oystercatchers, with which they were sometimes seen. On 1 July 1997 15 Pied and five Sooty Oystercatchers were observed roosting and flying together. Nesting of the former was observed in 1995, 1996 and 1997, on Quail Island only (SDW). Nests comprised a small depression in bare sand, similar to those of the Sooty Oystercatcher.

In 1996 three nests of the Pied Oystercatcher were found in the south-western portion of the island between 23 June and 14 July. One nest contained a single egg, while the other two had two eggs. On 23 June 1997

two nests were found in the south-eastern portion of the island; both had single eggs. No hatchlings or fledglings were observed.

The Pied Oystercatcher is common along the Northern Territory coastline (Crawford 1972; Storr 1977) but documented breeding records are scarce. Storr (1977) reported breeding in the Northern Territory during January, June and July, the latter months consistent with our data. However RC has three records of nests and eggs in September-October. As with the Sooty Oystercatcher the usual clutch is two eggs (Marchant & Higgins 1993), so it is intriguing that three of the five nests in Fog Bay contained single eggs, albeit possible that they were incomplete clutches.

Crested Tern

Crested Terns often roosted on Bare Sand and Quail Islands and Middle Reef, and during 1996 breeding was recorded at two sites. Approximately 200 eggs (presumably belonging to 200 pairs or nearly so) were counted on a sand-bank 1 km south of Bare Sand Island on 25 May (DD), and 160 eggs on a sand-bank at Middle Reef on 1 June (SDW). Courtship behaviour and fish-offering displays were observed. At both sites eggs were laid directly on the sand, in positions vulnerable to the tide. The mean length and width (± sd) of eight eggs, measured *in situ*, were 60.3 mm (± 0.31) and 41.9 mm (± 0.15), respectively.

An inspection of the sand-bank off Bare Sand Island on 3 June 1996, nine days after the discovery of the colony, revealed only stranded debris above the elevation of the colony, indicating that the eggs had been washed away by the high spring tides. Although White-bellied Sea-Eagles had been observed eating eggs on two occasions prior to this date, it is unlikely that their predation could result in the disappearance of 200 eggs within eight days. On a return visit to Middle Reef on 3 June, two days after the first visit, eggs were found only among debris along the strand-line of the last high tide. There was no evidence of nesting on the sandbank near Bare Sand Island in June or July 1997, when up to 400 birds were seen on the western beach of the Island. Middle Reef was not checked during this period.

In the Northern Territory most breeding colonies of the Crested Tern are situated on islands off Arnhem Land. Only two colonies have been found west of 134° E: one on Sandy Island off Cobourg Peninsula (Frith & Hitchcock 1974), and the other on Seagull Island, just north of Melville Island (R. Chatto, unpubl. data), about 250 km and 150 km from Fog Bay, respectively. The timing of breeding at Fog Bay is consistent with the May-July season reported for these and other colonies (Frith & Hitchcock 1974;

R. Chatto, unpubl. data). The failure of the colonies at Fog Bay, and the lack of other breeding records, despite extensive surveys of the region over the five years prior to 1996 (R. Chatto, unpubl. data), suggest that the birds were young and/ or inexperienced breeders, possibly derived from the abovementioned colonies. The dimensions of the measured eggs closely resemble those of other populations (Higgins & Davies 1996).

Black-naped Tern

Although Black-naped Terns were sighted during the present study, there was no evidence of them breeding. However during December 1989 Guinea & Ryan (1990) recorded nesting on Bare Sand Island. This is consistent with records from islands off the eastern coast of the Northern Territory, where the species typically breeds from August to January (Fisher *et al.* 1996; R. Chatto, unpubl. data). Our observations from Fog Bay apparently represent the most westerly records for this species in Australia. The nearest breeding colony to Fog Bay is on an island off Cobourg Peninsula (R. Chatto, unpubl. data).

Little Tern

An adult Little Tern was seen feeding a begging juvenile on Bare Sand Island on 21 December 1992 (RC). On 3 September 1995 at least 10 adults defended an area of sand and shale in the middle of the south end of the island (RC). These observations indicate that Little Terns, occasionally at least, nest on the island during the late dry-early wet seasons. Although Crawford (1972) and Storr (1977) described this species as a summer visitor to the Northern Territory from the Palearctic region only, recent surveys have confirmed that populations, probably belonging to a different race, breed at many sites around the Northern Territory coast in most months of the year, especially during May- July and September- November (R. Chatto, unpubl. data).

Little Corella

Groups of up to 20 Little Corellas frequently visited Bare Sand and Quail Island at various times of the day, including midday, presumably having travelled at least 10 km from the mainland. Birds were observed feeding on seeds from Dodder Laural *Cassytha filiformis* and coastal grasses and herbs. In May 1996 two Corellas picked at items as they walked along the one-hour old strandline on the southern end of the beach at Bare Sand Island.

Little Corellas are known to move daily to and from feeding areas in the early morning and late afternoon (Lendon 1973; Harman 1981), but we know of no documentation of daily movements to offshore islands, or of

feeding activity during the middle of the day. As the above food plants also occur on the mainland it it possible that the islands provide additional, unknown resources.

PLATE 7 Nest and eggs of Sooty Oystercatcher, Quail Island. (S. Whiting)

Other species

A first-year immature Spotted Harrier, perched on a small tree on Quail Island on 12 July 1996, was identified by its boldy barred tail, lack of streaking on underparts, and lack of pale patch on the nape (the latter two features, characteristic of the juvenile Swamp Harrier *C. approximans*). This species is a scarce dry season visitor to the Darwin region (Crawford 1972; Storr 1977). The Rose-crowned Fruit-dove owed its occurrence on Quail Island to the presence of fruiting monsoon vine-thicket plant species. At least two pairs of each of the mangal-specialised passerines (Broad-billed Flycatcher, Mangrove Golden Whistler and Mangrove Grey Fantail) were seen on Djedjelbity Islet in mangals dominated by the Star Mangrove *Sonneratia alba* and Stilt Mangrove *Rhizophora stylosa* (RAN). This is typical habitat for these species in the Top End, though the latter two species are uncommon in the Darwin region (Noske 1996).

Of at least nine species of honeyeaters occurring on the adjacent mainland, only the Brown Honeyeater was present at the time of our visits. On Quail

Island it was abundant and occupied every available habitat, consistent with its high abundance and ubiquitousness on the Wessel Islands (Fisher *et al.* 1996). The occurrence of the Restless Flycatcher in grasslands on the Fog Bay islands is somewhat surprising given that the Top End race is generally associated with paperbark woodlands and other riparian vegetation, especially in the dry season (Crawford 1972; Storr 1977).

Three Black-faced Cuckoo-shrikes moving through grasslands on Bare Sand Island on 26 May 1996 (DD), and a small flock of six (and another two on Djedjelbity Islet) on 12 July 1996 (RAN) may have been on migration to Indonesia, though the main passage through Darwin occurs in May (McKean 1986). However Mathews (1914) noted small parties flying high over trees on Melville Island between May and November, suggesting movements over a longer period.

Concluding remarks

The present study was conducted wholly within the dry season so it is likely that wet season surveys to the area will succeed in adding bird species and breeding records. The Bynoe Harbour-Fog Bay area is possibly regionally significant for the Beach Stone-curlew. Quail Island would make an excellent site for the study of this species which has declined in Australia and other parts of its range from human disturbance and destruction of its beach habitat, as well as from predation by introduced mammals (Garnett 1993).

Acknowledgements

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APPENDIX 1 Birds of islands north of Fog Bay.

Species Name	Scientific Name	BS	QI	DI	WI	MR
Orange-footed Scrubfowl	*Megapodius reinwardt*		X			
Brown Booby	*Sula leucogaster*	X	X			X
Darter	*Anhinga melanogaster*		X			
Little Pied Cormorant	*Phalacrocorax melanoleucos*			X		
Pied Cormorant	*Phalacrocorax varius*		X			X
Australian Pelican	*Pelecanus conspicillatus*	X	X			X
Lesser Frigatebird	*Fregata ariel*	X	X	X		
White-faced Heron	*Egretta novaehollandiae*		X			
Little Egret	*Egretta garzetta*	X				
Eastern Reef Egret	*Egretta sacra*	N*	X	X		
Great-billed Heron	*Ardea sumatrana*		N?	X		
Striated Heron	*Butorides striatus*			X		
Nankeen Night Heron	*Nycticorax caledonicus*	X	X			
Black-necked Stork	*Ephippiorhyncus asiaticus*	X	X			
Osprey	*Pandion haliatetus*		X			X
Whistling Kite	*Haliastur sphenurus*		X			
Brahminy Kite	*Haliastur indus*	X	X	X		X

continued

APPENDIX 1 (continued) Birds of islands north of Fog Bay.

Species Name	Scientific Name	BS	QI	DI	WI	MR
White-bellied Sea Eagle	*Haliaeetus leucogaster*	X	X	X		X
Spotted Harrier	*Circus assimilis*		X			
Brown Goshawk	*Accipiter fasciatus*		X	X		
Australian Hobby	*Falco longipennis*		X	X		
Nankeen Kestrel	*Falco cenchroides*	X	X			
Bar-tailed Godwit	*Limosa lapponica*	X			X	
Whimbrel	*Numenius phaeopus*	X			X	
Eastern Curlew	*Numenius madagascariensis*	X	X		X	
Common Greenshank	*Tringa nebularia*	X			X	
Terek Sandpiper	*Xenus cinereus*	X				
Grey-tailed Tattler	*Heteroscelus brevipes*	X		X	X	
Ruddy Turnstone	*Arenaria interpres*	X	X		X	
Asian Dowitcher	*Limnodromus semipalmatus*				X	
Great Knot	*Calidris tenuirostris*	X			X	
Red Knot	*Calidris canutus*	X			X	
Sanderling	*Calidris alba*	X				
Red-necked Stint	*Calidris ruficollis*	X			X	
Curlew Sandpiper	*Calidris ferruginea*	X				
Beach Stone-curlew	*Esacus neglectus*	X	N	X		
Pied Oystercatcher	*Haematopus longirostris*	X	N		X	
Sooty Oystercatcher	*Haematopus fuliginosus*	N	N			
Pacific Golden Plover	*Pluvialis fulva*	X				
Grey Plover	*Pluvialis squatarola*	X	X		X	
Lesser Sand Plover	*Charadrius mongolus*	X	X		X	
Greater Sand Plover	*Charadrius leschenaultii*	X	X		X	
Silver Gull	*Larus novaehollandiae*	X	X		X	X
Gull-billed Tern	*Sterna nilotica*	X			X	
Caspian Tern	*Sterna caspia*	X	X		X	
Lesser Crested Tern	*Sterna bengalensis*	X	X			X
Crested Tern	*Sterni bergii*	N	X		X	N
Black-naped tern	*Sterna sumatrana*	N*	X			X
Common Tern	*Sterna hirundo*	X				
Little Tern	*Sterna albifrons*	N?				
Whiskered Tern	*Chlidonia hybridus*	X				
White-winged Black Tern	*Chlidonias leucopterus*	X	X			

continued

APPENDIX 1 (continued) Birds of islands north of Fog Bay.

Species Name	Scientific Name	BS	QI	DI	WI	MR
Rose-crowned Fruit Dove	*Ptilinopus regina*			X		
Little Corella	*Cacatua sanguinea*	X	X			
Rainbow Lorikeet	*Trichoglossus haematodus*	X				
Sacred Kingfisher	*Todirhamphus sanctus*		X			
Collared Kingfisher	*Todirhamphus chloris*	X	X	X		
Rainbow Bee-eater	*Merops ornatus*	X	X	X		X
Brown Honeyeater	*Lichmera indistincta*	X	X	X		X
Lemon-bellied Flycatcher	*Microeca flavigaster*		X	X		
Mangrove Golden Whistler	*Pachycephala melanura*			X		
Broad-billed Flycatcher	*Myiagra ruficollis*	X		X		
Restless Flycatcher	*Myiagra inquieta*	X	X	X		
Rufous Fantail	*Rhipidura rufifrons*			X		
Mangrove Grey Fantail	*Rhipidura phasiana*			X		
Northern Fantail	*Rhipidura rufiventris*		X			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	X	X	X		
Olive-backed Oriole	*Oriolus sagittatus*			X		
White-breasted Woodswallow	*Artamus leucorhynchus*	X	X	X		X
Richard's Pipit	*Anthus novaeseelandiae*	X	X			
Chestnut-breasted Mannikin	*Lonchura castaneothorax*	X				
Mistletoebird	*Dicaeum hirundinaceum*		X	X		
Tree Martin	*Hirundo nigricans*	X				
Yellow White-eye	*Zosterops luteus*	X	X	X		
Total no. species		52	46	26	18	13

BS, Bare Sand Is; QI, Quail Is; DI, Djedjelbity Islet; WI, Windir Is; MR, Middle Reef; X, present; N, nesting; N?, nesting suspected; *, Guinea & Ryan (1990). Sequence follows Christidis & Boles (1994).

SHORT NOTES

A Capture Record of the Northern Shrike-tit

The Northern Shrike-tit *Falcunculus frontatus whitei* is one of the least known of Australia's endemic birds, having been reported fewer than 30 times (Robinson & Woinarski 1992), and apparently never captured alive. Its scarcity is perplexing and does not obviously reflect the availability of the tropical woodland habitat it occupies. Garnett (1992: 164) rated the subspecies "Insufficiently Known" and urged that "sight records should be followed up to determine critical aspects of its ecology".

On the morning of 28 November 1996 we inadvertently captured a single Northern Shrike-tit in a mist net in the vicinity of the junction of the Stuart Highway and the Edith Falls Road between Pine Creek and Katherine in the Northern Territory. The capture occurred whilst we were attempting to net Gouldian Finches *Erythrura gouldiae*. Following its release we observed the bird for about ten minutes before it flew out of sight, but it was not observed to feed.

On the basis of criteria described by Rogers *et al.* (1986) for the Eastern Shrike-tit *F. f. frontatus*, the bird we caught was a sub-adult male. It was darker and duller above than illustrated by Simpson & Day (1993) and had brown tail feathers and blue legs, and was much duller below than the photograph in Boles (1988), differences which may be attributable to its age. With a weight of 23.5 g and a head-bill length of 36.6 mm, the bird was much smaller than the Eastern Shrike-tit in Victoria (Rogers *et al.* 1986), consistent with comparisons in general texts (e.g. Simpson & Day 1993). The bird we caught was in the early stages of primary moult, but no other moult was present. Its two central tail feathers were much more worn than the other five pairs.

The bird was captured in a 40 m wide cleared easement through woodland on sandy, granitic soils. The adjacent undisturbed woodland was dominated by Darwin Woollybutt *Eucalyptus miniata* and secondarily by Ironwood *Erythrophleum chlorostachys*, Salmon Gum *Eu. tintinnans* and Round-leaved Bloodwood *Corymbia latifolia*, with a variety of other tree species present in small numbers. This is within the range of habitats described for the subspecies by Robinson & Woinarski (1992).

We think it curious that this sighting was made at a location where the threatened Gouldian Finch, another bird with a notably sparse and patchy distribution in the tropical woodlands, was present. This could, of course,

be a simple artefact; our activities in the area were focussed on Gouldian Finch sites. However, a number of previous reports have also been at known Gouldian Finch sites, e.g. Mt Todd and Timber Creek (Robinson & Woinarski 1992). Furthermore, three recent sightings in the Kimberley region of Western Australia were all in the immediate vicinity of Gouldian Finches (G. Swann, pers. comm.). There is no likelihood of similarity in the foraging ecology of the two species. We are tempted to speculate that subtle commonalities of habitat may draw the two species to the same sites, perhaps in response to fire regimes.

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First Breeding Record of the Cicadabird in the Northern Territory

The Cicadabird *Coracina tenuirostris* occurs widely from South Sulawesi and Timor in eastern Indonesia, through northern and eastern Australia, to New Guinea and the Solomons. In the Northern Territory it is known to occur from Darwin in the west to Groote Eylandt in the east, and is separated from populations on Cape York by a gap of some 500 km (Blakers *et al.* 1984). Very little is known about this species in the Top End and there appear to be no published records of it breeding.

Over a period of nearly five years in the Darwin region, Crawford (1972) listed only six records of Cicadabirds, while McKean (1986) recorded them only nine times during ten years (1974-1984) of observations in the Sanderson Sewage Ponds area. Local habitats include paperbark (*Melaleuca* spp) woodlands, monsoon rainforests, mangals, and occasionally eucalypt forests (White 1917; Deignan 1964; Crawford 1972; Boekel 1976; McKean 1986). Noske (1996) recorded one or two pairs of the species each wet season over six years at his mangal site near Darwin, and suspected breeding in paperbarks fringing the landward edge of the mangal. Male Cicadabirds collected in November and January in Darwin had enlarged testes (McKean 1986). The species breeds mainly during the summer months in eastern Australia (Marchant 1979; Lavery 1986).

On 15 December 1997 RAN watched a male Cicadabird for 1 h in Yellow-barked Paperbark *Melaleuca nervosa* woodland surrounded by Darwin Woollybutt *Eucalyptus miniata*-dominated open forest, within the grounds of the Territory Wildlife Park, 40 km S of Darwin, where the species has been recorded regularly (D. Franklin pers. obs.). A female was seen only briefly, suggesting it was brooding on a nest. For about 5 min within this period the male repeatedly "dive-bombed" a Pheasant Coucal *Centropus phasianus* perched 10 m above the ground in a eucalypt. On each occasion it flew between the tops of two trees about 30 m from the Coucal in opposite directions, giving a sharp alarm call as it almost touched the latter.

Returning to the site TAB and VB flushed a female Cicadabird, and after searching the immediate vicinity found a shallow nest typical of *Coracina* species. RAN climbed the nest-tree and sighted a single egg in the nest. Although only 6 m above the ground and placed on a horizontal fork of a Yellow-barked Paperbark, the nest was barely noticeable from eye-level. We believe this to be the first documented breeding record of the Cicadabird

in the Northern Territory. Marchant (1979) noted that all published records of the clutch of this species are of one egg, and that only the female incubates.

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